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P01/7700 25.00 - 9718831.2

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

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1. Your reference **P/61149.GBA/GPTU11/APC**

2. Patent application number *(The Patent Office will fill in this part)* 05 SEP 1997 **9718831.2**

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

GPT LIMITED
NEW CENTURY PARK
P.O. BOX 53
COVENTRY
CV3 1HJ

Patents ADP number *(if you know it)* 58718270002

If the applicant is a corporate body, give the country/state of its incorporation **ENGLAND**

4. Title of the invention
DATA TRANSMISSION IN AN SDH NETWORK

5. Name of your agent *(if you have one)* **H A BRANFIELD**

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

GEC PATENT DEPARTMENT
WATERHOUSE LANE
CHELMSFORD
ESSEX CM1 2QX

Patents ADP number *(if you know it)* **5858519002**

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body
See note (d))

YES

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	0
Description	7
Claim(s)	3
Abstract	0
Drawing(s)	1

10. If you are also filing any of the following, state how many against each item.

Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	0
Request for preliminary examination and search (Patents Form 9/77)	1
Request for substantive examination (Patents Form 10/77)	1
Any other documents *(please specify)*	0

11. I/We request the grant of a patent on the basis of this application.

H A BRANFIELD
Signature

Date **04/09/97**

12. Name and daytime telephone number of person to contact in the United Kingdom **ALAN CARDUS: (01245) 275124 -**

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DATA TRANSMISSION IN AN SDH NETWORK

The present invention relates to the field of synchronous digital hierarchy (SDH) networks and data transmission therein.

In SDH data is transfered in information structures known as virtual containers. A virtual container (VC) is an information structure within SDH which consists of an information payload and path overhead (POH). There are two types of VC: low order (LOVC) and high order (HOVC). LOVC's (eg. VC-12, VC-2 and VC-3) are for signals of less than 140Mb/s and HOVC's (ie. VC-4) are for 140Mb/s signals.

With the ever increasing demand for higher data rates there is a continuing need to improve the data transfer capability of networks such as those based on SDH. One way of providing higher bandwidth is concatenation.

Concatenation is a method for the transport over SDH networks of a payload of a bandwidth greater than the capacity of the defined information structures. ITU standard G.707 defines concatenation as follows: a procedure whereby a multiplicity of virtual containers is associated one with another with the result that their combined capacity can be used as a single data container across which bit sequence integrity is maintained. Two types of concatenation have been proposed: contiguous and virtual.

Contiguous concatenation is defined in ITU standards such as G.707. Virtual

concatenation for VC-2 has also been identified in ITU G.707 but the means for implementing it has not previously been defined and it has therefore not been implemented. Virtual concatenation for VC-4 has been proposed as a concept but no way of implementing has been devised until now. Furthermore, no method of performing conversion between contiguously concatenated signals and virtually concatenated signals has been defined.

Contiguous concatenation uses a concatenation indicator in the pointer associated with each concatenated frame to indicate to the pointer processor in the equipment that the VC's with which the pointers are associated are concatenated. For example, by contiguously concatenating four VC-4's an information structure with a data rate equivalent to a VC-4-4c could be created. The resulting VC-4-4c equivalent signal has only one path overhead (i.e. 9 bytes only). However many installed SDH networks cannot carry out the necessary processing to support contiguous concatenation. In order to implement contiguous concatenation in such SDH networks it would be necessary to modify the hardware of the equipment in order to handle the concatenated signal. Suitable modification of such a network would be prohibitively expensive.

This can cause a problem when the customer wishes to transfer data which requires a bandwidth too high for the installed SDH network to handle, such as some broadband services. For example a customer may wish to transfer data in VC-4-4c format but would be unable to transport it over current SDH networks which do not support concatenation.

The object of the invention is an SDH network with the capability of carrying signals of increased bandwidth. A further object is to provide for the information content of an STM signal carrying data in contiguously concatenated virtual containers to be transmitted over an SDH network not itself capable of carrying contiguously concatenated signals.

The present invention provides a method for the transmission of data in a synchronous digital hierarchy (SDH) network comprising the steps of transmitting to a node of the network a form of data signal from outside the network, converting the signal into a virtually concatenated information structure and transporting the signal through the network in the virtually concatenated information structure.

The present invention advantageously provides a method for converting contiguously concatenated signals into virtually concatenated signals for transport in the network.

The present invention provides a means for carrying out any of the above methods.

The present invention also provides a synchronous digital hierarchy (SDH) network in which data is carried in a virtually concatenated information structure, the network comprising tributary cards arranged and configured to process signals received in contiguously concatenated form to convert them into virtually concatenated form for transfer across the network.

In a preferred embodiment the data transfer is achieved by means of a virtually

concatenated information structure equivalent to VC-4-4c comprising a set of four virtually concatenated VC-4 signals. This virtually concatenated information structure is referred to in the following by the acronym "VC-4-4vc": this being chosen to reflect the fact that the data rate is the same as that of VC-4-4c, with the "vc" indicating virtual concatenation.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawing which shows conventional STM information structures.

Referring to Figure 1, this shows synchronous transfer module STM comprising a section overhead SOH, a pointer and a virtual container VC. The VC in turn comprises a path overhead POH, fixed stuff bytes and a container C for the payload.

A network management system manages the transfer of virtually concatenated VC-4's without any modification being required to network equipment. The only hardware modification required is the provision of modified tributary cards capable of identifying the receipt at the network boundary of contiguously concatenated VC-4's and processing them accordingly. Individual VC-4's and virtually concatenated VC-4's are transported in the SDH network in the same way. Hence, four VC-4's, when virtually concatenated, will still have four path overheads.

In the standard configuration a tributary card accepts at its input and delivers at its output an STM-4 signal containing four independent VC-4's (by way of example, each may

contain a 140Mb/s, 3 x 34Mb/s or 63 x 2Mb/s mapped PDH signals). However, the new tributary card is also capable of accepting at its input and delivering at its output an STM-4 signal containing four contiguously concatenated VC-4 signal,: as for example may arise from mapping ATM cells into STM-4 to ITU recommendations I.432 and G.707.

The tributary card will recognise the format of the incoming STM-4 signal as a contiguously concatenated signal using the concatenation indication in the pointer and act accordingly.

Optionally, the tributary card could also be configured to handle STM-4 signals containing four virtually concatenated VC-4 signals, to meet future market opportunities. The tributary card STM-4 interface meet the requirements of G.957 and G.958. The transport of the ATM/STM-4 signal ovcr the SDH network is transparent and SDH parameters processing and performance monitoring shall apply according to G.826, G.707, G.783 and ETS300 417.

At the ATM/STM-4 input port the pointers of the four concatenated VC-4's are aligned. The resulting, newly generated four VC-4's are processed for transfer across the network as a virtually concatenated information structure (VC-4-4vc) signal by processing their associated path overheads as follows.

Whereas the pointer can indicate delay of the concatenated VC-4's in the VC-4-4vc of up to one frame duration (i.e. 125 μs) higher delays cannot be picked up in this way.

Since the differential delay between the VC-4s of a VC-4-4vc as they are transported across the SDH network are unknown, it is necessary to take steps to ensure that the VC-4s so transferred are in the correct sequence. The path trace (J1) value for each of the VC-4's in the VC-4-4vc is given a unique code indicating their order within the VC-4-4vc.

It is also necessary to ensure that the frames of each VC-4 in the VC-4-4vc are correctly ordered. The H4 byte is therefore used for frame sequence indication (FSI) to allow the network to recover the original sequence.

A signal label code is inserted in the C2 byte of each VC-4 of the VC-4-4vc to indicate the payload type, eg an ATM payload, as required. The B3 byte of the received contiguous VC-4-4c signal is processed, as appropriate, to maintain the path integrity.

On the back-plane port of the network node which receives the VC-4-4vc signal the virtually concatenated VC-4's of the VC-4-4vc are aligned using a buffer according to the information provided by the path trace values and the frame sequence values. The size of the buffer is dependent on the maximum differential delay allowed between the VC-4's which constitutes the VC-4-4vc. A value of 8 milliseconds is proposed, by way of example, based on the use of the H4 byte to indicate the frame sequence. However such a buffer size may prove prohibitively large. Therefore it may be necessary to reduce the buffer size by ensuring that the differential delay is kept to the absolute minimum. This may be achieved by ensuring that the four VC-4's in the VC-4-4vc are processed and switched together as well as being transmitted together in the same

synchronous transfer module (STM), e.g. STM-4, STM-16, STM-64, and along the same route through the network.

Path trace mismatch on any of the VC-4 in the VC-4-4vc will result in trace mismatch defects on the VC-4-4vc signal. Similarly, signal label mismatch and loss of signal (LOS) of any VC-4 in the VC-4-4vc will result in alarm indication signal (AIS) in the VC-4-4vc.

The pointers, concatenation indicators and path overhead bytes must be restored as appropriate before the signal is transmitted as a contiguous signal outside of the network. The path overhead information in the first VC-4 frame in the received virtual concatenated VC-4-4vc signal is inserted in the path overhead of the contiguous concatenated VC-4-4c signal generated by the network for transmission outside the network. Additionally, the B3 value is corrected as appropriate to maintain the path's integrity and is inserted in the contiguous VC-4-4c path overhead. Thus the output port delivers an STM signal identical to that presented at the input port.

In a typical system performance reports and alarms would be passed to the element manager (EM). The EM (and SDH network management system) may be required to configure the VC-4's which constitute the VC-4-4vc in a preferred manner.

The above embodiment is described by way of example only and does not limit the scope of the invention. In particular the present invention applies equally to signals and information structures other than VC-4, for example to VC-3, VC-2 and VC-1.

Claims

1. A method for the transmission of data in a synchronous digital hierarchy (SDH) network comprising the steps of transmitting to a node of the network a form of data signal from outside the network, converting the signal into a virtually concatenated information structure and transporting the signal through the network in the virtually concatenated information structure.

2. The method of Claim 1 comprising the step of converting the signal so transported into a signal of the same form as that transmitted to the network.

3. The method of any one of the above claims wherein the signal transmitted to the network from outside the network is in contiguously concatenated form.

4. The method of any one of the above claims wherein conversion of the signal comprises processing a path overhead of the signal.

5. The method of Claim 4 wherein the path overhead comprises bytes H4, J1 and B3; the step of processing the path overhead including the steps of using byte H4 for indicating frame sequence within the VC-4, using byte J1 to indicate the order of VC-4s in a virtually concatenated information structure and correcting, as necessary, the error indication information carried in byte B3.

6. The method of Claim 5 comprising the steps of transmitting to a node of the

network a signal from outside the network in a form comprising four contiguously concatenated VC-4 signals and processing the four VC-4 signals into a virtually concatenated information structure for transfer across the network.

7. The method of Claim 6 comprising the step of aligning the virtually concatenated frames of the virtually concatenated information structure using a buffer.

8. The method of Claim 7 comprising the step of controlling the alignment according to the contents of bytes J1 and H4.

9. The method of any one of Claims 6 to 8 comprising the steps of switching and transmitting the VC-4 frames of the virtually concatenated information structure through the network together in a single synchronous transfer module (STM) or in multiple STMs and via the same route.

10. The method of any one of the above claims comprising the step of recognising the receipt of a signal in concatenated form by the network.

11. A means for carrying out the method of any one of the above claims.

12. A synchronous digital hierarchy (SDH) network in which data is carried in a virtually concatenated information structure, the network comprising tributary cards arranged and configured to process signals received in contiguously

concatenated form to convert them into virtually concatenated form for transfer across the network.

13. The network of Claim 12 wherein the tributary cards are arranged and configured to process signals transferred across the network in virtually concatenated form and to convert them into contiguously concatenated form.

14. The network of Claim 13 wherein the signals in virtually concatenated form comprise virtual containers (VC) and the tributary cards comprise one or more buffers for aligning said virtual containers (VC).

15. The network of any one of the Claims 12 to 14 wherein the tributary cards are configured and arranged to detect the receipt of signals in contiguously concatenated form by detecting a concatenation indication of the signals received.

16. A method for the transmission of data in a SDH network substantially as herein described with reference to the drawing.

17. An SDH network for transmission of data substantially as hereinbefore described with reference to the drawing.

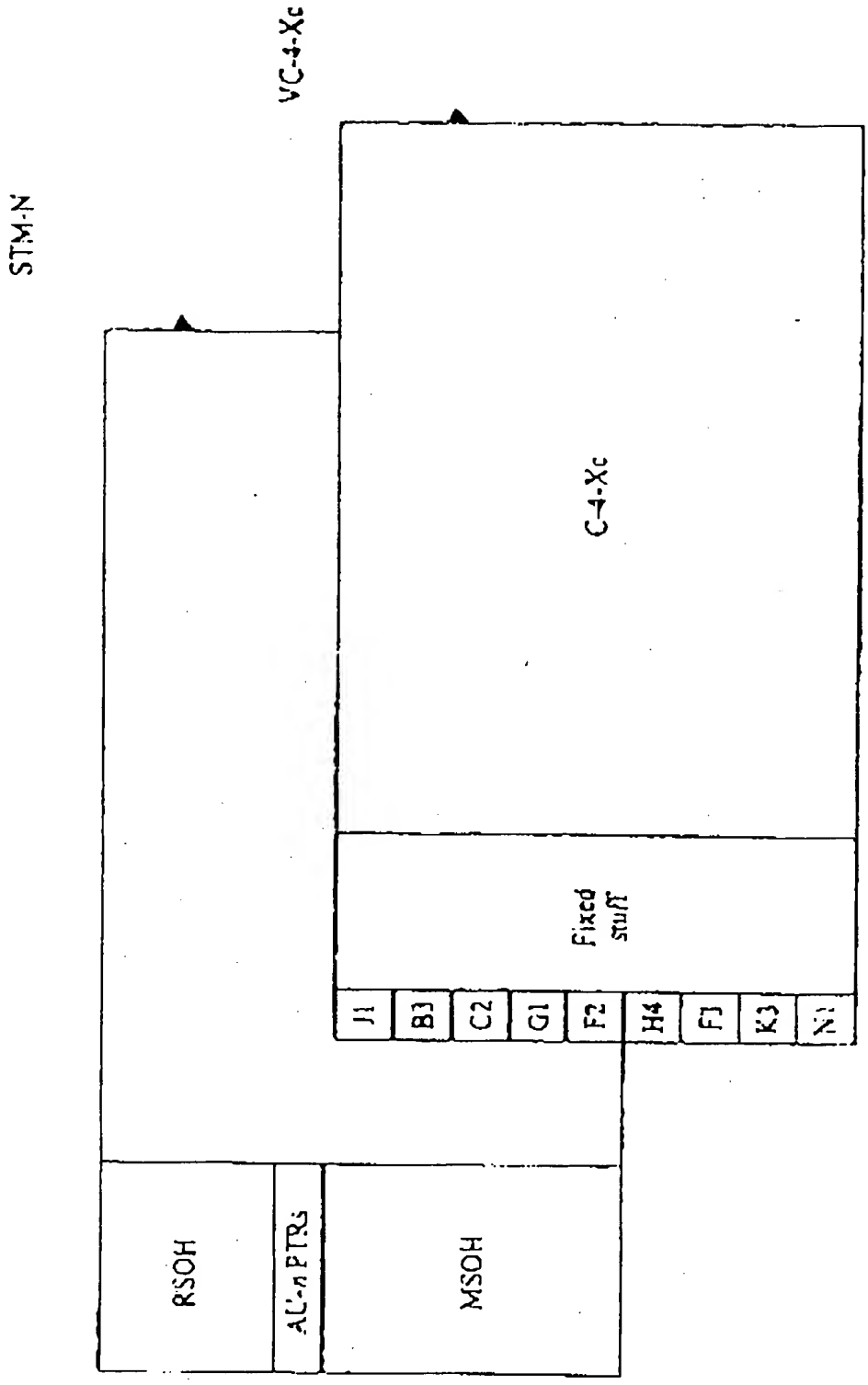
STM-N
VC-4-Xc
C-4-Xc
Fixed stuff
J1
B3
C2
G1
F2
H4
F3
K3
N1
RSOH
AU-n PTRs
MSOH

Figure 1.